

DOCUMENT RESUME

ED 280 947

CE 046 628

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TITLE Assessing the Effect of Increased High School Graduation Requirements and the Development of Models to Minimize the Impact on Enrollment in Vocational Courses. Final Research Report.
SPONS AGENCY Colorado State Board for Community Colleges and Occupational Education, Denver.
PUB DATE Nov 86
NOTE 81p.; Some light type may not reproduce well. For executive summary, see ED 277 852.
PUB TYPE Reports - Research/Technical (143)
EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Academic Standards; Competency Based Education; *Credits; Criterion Referenced Tests; *Curriculum Development; *Enrollment Influences; *Graduation Requirements; Mathematics Curriculum; Models; Questionnaires; Science Curriculum; Secondary Education; Statewide Planning; *Vocational Education
IDENTIFIERS *Colorado; Impact Studies

ABSTRACT

A study examined the effect that increased high school graduation requirements are having on Colorado vocational enrollments and explored products and models for educators in school districts to use in minimizing any such adverse effects on enrollment. The study entailed a literature review, a survey of state high school science and mathematics supervisors, and examination of curriculum guides from various states to identify common mathematics and science skills. Next, 13 occupational courses were used to illustrate how the identified list of suggested skills can be coded to highlight the many essential skills that can and are being taught through vocational courses. A set of models was developed, and recommendations were made for local school districts working to minimize adverse effects of increased graduation requirements on vocational enrollments. The five models developed revolved around the following accreditation options: offering direct credit for vocational courses; awarding shared credits for vocational courses; competency testing in lieu of credits required; requesting policy changes at the local district level to reduce established credit requirements based on coded skills, tests, demonstrated occupational needs of students, and national and state trends; and adopting or adapting a successful model from exemplary programs in other districts. (Appendixes to this report include a review of related literature, a state science and mathematics survey, suggested criterion-referenced tests of essential skills, and codings of science and mathematics to suggested essential skills included in vocational courses.) (MN)

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C08613101

FINAL RESEARCH REPORT

ASSESSING THE EFFECT OF INCREASED HIGH SCHOOL GRADUATION REQUIREMENTS AND THE
DEVELOPMENT OF MODELS TO MINIMIZE THE IMPACT ON ENROLLMENT IN VOCATIONAL COURSES

by

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Prepared for the
Colorado State Board for Community Colleges
and Occupational Education
Occupational Division

November, 1986

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STATE OF COLORADO

STATE BOARD FOR COMMUNITY COLLEGES AND OCCUPATIONAL EDUCATION

RFP-FY86-R2

ASSESSING THE EFFECT OF INCREASED HIGH SCHOOL GRADUATION REQUIREMENTS AND THE
DEVELOPMENT OF MODELS TO MINIMIZE THE IMPACT ON ENROLLMENT IN VOCATIONAL COURSES

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November, 1986

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BY

Glyn H. Sharpe

November, 1986

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FOREWORD

The procedures and results described in this report are a part of the total effort supported by the Colorado State Board of Community Colleges and Occupational Education. A companion study directed by Dr. Harold Anderson describes other aspects of the total research.

An executive summary was prepared combining the results of the separate efforts. Readers may want to refer to both of these documents in considering the findings and recommendations.

Much of the support justifying the development of the products (essential skills, criterion tests and codings of science and mathematics to occupational courses) is based on what is commonly used and what is commonly tested. These products must be validated by use before strong research claims can be made about their effectiveness.

The cooperation of the Colorado Department of Education was of great value with the surveys, support for the project efforts and in including the research as an agenda item in the regional meetings conducted during the fall of 1986. The help of the Occupational Education Division and the support and advice of Dr. Harold Anderson were very helpful in completing the study.

INTRODUCTION

The 1984 Gallop Poll reported that the general public believes that 96% of students who enter college should be required to study mathematics. 92% of those surveyed believed that even students who do not enter college should also study mathematics. This was true even though many of the participants in the poll did not either like mathematics or choose mathematics as an elective in either high school or college.

There was general agreement on the importance and support of basic courses to be required in both science and mathematics. There seemed to be great and continuing commitment to additional courses without specifying what skills are essential or what skills the courses are to develop. The necessary skills are to be mastered by exposure and completion of the courses.

Colorado schools have followed the national trends by adding courses in many of the high schools. The Colorado Department of Education does not mandate any required courses in science or mathematics.

Additional courses are usually placed into an already crowded high school curriculum. Pressures and loss of enrollment in the elective areas usually are the result. A large percentage of students could lose the counseling and career preparation in vocational education programs.

Much of the emphasis of this study was on the development of products and models that will help educators in school districts deal with the issues and the consequences of the additional requirements. The models offer options and some middle ground where science and mathematics skills can be assured and the programs in vocational education and other areas can be continued.

OBJECTIVES

The study was conducted to accomplish the following objectives:

1. To review literature concerning science and mathematics competencies and requirements for graduation from high school.
2. To survey state science and mathematics supervisors to determine the number of science and mathematics courses mandated by the states for graduation.
3. To develop a suggested list of essential skills in both science and math.
4. To develop criterion tests in science and mathematics that could be used to measure the essential skills.
5. To code several occupational courses to the essential skills in science and mathematics.
6. To develop models that offer alternative options to schools in lieu of adding additional requirements in science and mathematics.
7. To make some recommendations for SBCCOE to consider for possible follow-up with local districts to minimize the adverse effects of increased courses in science and mathematics.
8. To suggest a plan of action for SBCCOE concerning the findings and recommendations of the study.
9. To seek and list the exemplary programs in Colorado schools that have dealt with the problems and have successfully maintained or increased their own vocational programs.

PROCEDURES

The following procedures were utilized in completing the objectives of the study:

1. A review of the current literature was made. References of the major sources are included in Appendix A.
2. A Questionnaire was developed to survey the state science and mathematics supervisors. The responses were summarized and compared with results in 1984 that were assed by the Education Commision of the States. The letters and the survey documents are included in Appendix B.
3. Curriculum guides from the states were studied to determine which science and mathematics skills were common to most. Several standardized tests were studied as another criteria to help determine what skills were either studied or were tested by great numbers of educators. The skills in science and mathematics that were included in most of these documents were identified and listed as essential skills and were used to generate test items and for course codings.

The skills are listed as a part of the findings of this study. Criterion tests for science and mathematics are included in Appendix C.

4. Thirteen of the occupational courses were used to illustrate how the list of suggested skills can be coded to highlight how many of the essential skills are applied during the instruction within a vocational course. A summary of these codings is shown in the findings. Individual courses are in Appendix D.
5. Models were developed from an analysis of the findings, interviews with vocational educators and high school principals and from suggestions from a study of the literature. These options are presented as a section of this report.
6. Recommendations were made based on the survey results, developed products and what seems to be needs and demands from local school districts.
7. A suggested plan of action was developed for possible follow-up by the SBCCOE.

FINDINGS

The major findings of the study are presented in some detail on the pages that follow. The abstract of the study is condensed in a section presented as a separate part of the study:

1. A review of the literature and the survey of the state supervisors of science and mathematics highlighted the feelings and commitment of the general public and many educators to be as follows:
 - a. School improvement in science and mathematics has been targeted as a high priority.
 - b. Additional course requirement is the methodology to accomplish the priority.
 - c. Most of the states increased course requirements in science and mathematics prior to 1984. The situation in 1986 is static for the most part.
 - d. The trend to increase course requirements is continuing at the local school district level. This is certainly the case in Colorado where there are no state mandated courses required.
 - e. Public opinion seems to be the change agent driving schools towards the implementation of additional course requirements.
 - f. The kind of science and mathematics making up the additional courses is a college-bound rather than an applied science and mathematics.

The following pages summarize the findings of the survey completed by responses from the state science and mathematics supervisors. The results were tabulated to show comparisons and trends:

SUMMARY OF THE STATES ON SCIENCE AND MATHEMATICS REQUIREMENTS

AREA	YEARS REQUIRED				TESTING REQUIRED		REQUIREMENTS ARE MET BY:		OTHER COURSES SUBSTITUTED		TRENDS SINCE 1984		ESSENTIAL SKILLS ARE LISTED	
	3	2	1	0	Yes	No	Courses	Testing	Yes	No	Increase	Decrease	Yes	No
SCIENCE	5	30	8	7	4	46	40	2	14	31	4	1	16	34
MATHEMATICS	9	33	1	7	14	36	39	3	16	30	3	0	15	35

The preceding comparison used the Education Commission of the States Report of minimum high school requirements completed in August, 1984 as the baseline data for the comparisons and trends. The 1986 data came from a survey of state science and mathematics supervisors. Several telephone calls were necessary to complete the all-state report. The results of the survey are summarized above.

Results:

1. Course requirements tend to be a little higher in mathematics than in science with 42 of the states requiring more than 2 courses for graduation.
2. Testing required for graduation is much higher in mathematics. A majority of the states do not require the state testing.
3. Courses completed is the methodology required by most of the states to satisfy the requirements.
4. About one third of the states will allow at least one course from other areas to satisfy science and mathematics requirements. There were several conditions listed in several cases.
5. A static situation exists as to increasing requirements at the present time. More than one half of the states indicated that requirements had been increased during the three years prior to 1986.
6. About one third of the states list essential skills for the two areas. The requirements are in place without a clear definition of what is expected from the students.

FINDINGS (Continued)

2. The following summaries indicate criteria for selecting the essential skills:

SUGGESTED ESSENTIAL MATHEMATICS SKILLS (9-12)

SKILL	Ga.	Tx.	Ill.	Wy.	N.M.	NCTM	NCSM	NAEP	GED	CTBS	MAT	TAP	McG	INCLUSION
1. Adds Whole Numbers	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
2. Adds Fractions	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
3. Adds Decimals	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
4. Subtracts Whole Numb.	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
5. Subtracts Decimals	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
6. Subtracts Fractions	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
7. Multiplies Whole Numb.	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
8. Multiplies Decimals	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
9. Divides Whole Numbers	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
10. Divides Decimals	X	X	X	X	X	X	X	X	X	X	X	X	X	13/13
11. Converts Fract→Dec.	X	X	X	X	X	X	X	X		X	X	X	X	12/13
12. Converts Fract.→%	X	X	X	X	X	X	X	X		X	X	X	X	12/13
13. Converts Dec→%	X	X	X	X	X	X	X	X		X	X	X	X	12/13
14. Measures Perimeter	X	X	X	X	X	X	X	X		X	X	X		11/13
15. Measures Volume	X	X	X	X	X	X	X	X		X	X	X		11/13
16. Measures Area	X	X		X	X	X	X	X		X	X	X		10/13
17. Determines Proportions	X	X		X		X	X	X		X	X	X	X	10/13
18. Determines Ratios	X	X		X	X	X	X	X		X	X	X		10/13
19. Measures Temperature	X	X			X	X	X	X		X	X	X	X	10/13
20. Rounds Numbers	X	X	X	X	X	X	X	X		X		X		10/13
21. Averages Numbers	X	X	X		X	X	X	X		X	X	X		10/13
22. Interprets Data	X	X		X	X	X	X	X			X	X	X	10/13

ESSENTIAL SKILLS FOR SCIENCE (9-12)

SKILL	Ca	Fla	Ill	Mo	N.H.	Ky	TAP	SRA	SAT	MAT	NAEP	INCLUSION
1. Describes Atomic Nature of Matter	X	X	X	X	X	X	X	X	X	X	X	11/11
2. Describes Forms of Energy	X	X	X	X	X	X	X	X	X	X	X	11/11
3. Interprets Matter-Energy Relations	X	X	X	X	X	X	X	X	X	X	X	11/11
4. Identifies Forces	X	X	X	X	X	X	X	X	X	X	X	11/11
5. Measures Forces	X	X	X	X	X	X	X	X	X	X	X	11/11
6. Solves Density Problems	X	X	X		X	X	X	X		X	X	9/11
7. Conserves Mass, Area & Volume	X	X			X		X		X	X	X	7/11
8. Classifies With Several Dichotomies	X	X	X	X	X	X	X	X	X	X	X	11/11
9. Describes Life Requirements	X	X	X	X	X	X	X	X	X	X	X	11/11
10. Compares States of Matter	X	X	X	X	X			X	X	X	X	9/11
11. Cause/Effects on the Environment	X	X		X	X	X		X	X	X	X	9/11
12. Describes Cycles and Phases (Nature)	X	X		X	X	X	X	X	X		X	9/11
13. Infers Weather Cause/Effects	X	X		X		X	X		X	X	X	8/11
14. Models Data	X	X		X	X	X	X	X	X	X	X	10/11
15. Interprets Data	X			X	X		X	X	X	X	X	8/11
16. Describes Cellular Nature of Org.	X	X	X	X	X	X	X	X	X	X	X	11/11
17. Compares Plants and Animals	X	X		X	X		X	X	X	X	X	9/11
18. Interprets the Water, Carbon Dioxide, and Nitrogen Cycles		X		X	X	X			X	X	X	7/11
19. Predicts Population Futures	X	X		X	X	X	X	X	X	X	X	10/11
20. Designs Fair Tests For Phenomena		X		X	X	X	X	X	X	X	X	9/11
21. Compares Physical and Chem. Changes	X	X	X	X	X	X	X	X	X	X	X	11/11
22. Interprets Sys., Organs & Tissues	X	X	X	X	X	X	X	X	X	X	X	11/11
23. Infers and Hypothesizes From Data	X	X	X	X	X	X	X	X	X	X	X	11/11

Tests Included:
TAP - Test of Academic Progress
SRA - Science Research Association
SAT - Stanford Achievement Test
MAT - Metropolitan Achievement Test
NAEP - National Assessment of Education Progress

SUMMARY-CODING BY VOCATIONAL AREA TO ESSENTIAL MATHEMATICS SKILLS

SKILL	Auto Mech.	Auto Body	Ind. Arts	Draft.	Const.	Metals	Heal. Occ.	Food Ser.	Elec.	Electro- Mech.	Comm. Art	Graph- Arts	Agri- Occ.
1. Adds Whole Num.	X	X	X	X	X	X	X	X	X	X	X	X	X
2. Adds Fractions	X	X	X	X	X		X	X	X	X			X
3. Adds Decimals	X	X	X	X	X	X	X	X	X	X	X	X	X
4. Subtracts Whole Num	X	X	X	X	X	X	X	X	X	X	X	X	X
5. Subtracts Decimals	X	X	X	X	X	X	X	X	X	X	X	X	X
6. Subtracts Fractions	X				X		X	X	X	X			X
7. Multiplies Who. Num	X	X	X	X	X	X	X	X	X	X	X	X	X
8. Multiplies Decimals	X	X	X	X	X	X	X	X	X	X	X	X	X
9. Divides Whole Num.	X	X	X	X	X	X	X	X	X	X	X	X	X
10. Divides Decimals	X	X	X	X	X	X	X	X	X	X	X	X	X
11. Converts Fract-Dec	X												
12. Converts Fract-%	X						X	X					
13. Converts Dec-%	X				X		X	X			X		X
14. Measures Perimeter	X		X		X	X				X			X
15. Measures Volume	X		X		X	X				X			X
16. Measures Area	X	X	X		X	X		X		X	X		X
17. Det. Proportions				X	X		X				X	X	
18. Measures Temper.	X						X	X	X				X
19. Det. Ratios	X			X	X	X					X	X	
20. Rounds Numbers													
21. Averages Numbers		X	X		X								X
22. Interprets Data			X				X		X				X

FINDINGS (Continued)

SUMMARY-CODING BY VOCATIONAL AREA TO ESSENTIAL SCIENCE SKILLS-COLORADO

SKILL	Auto Mech.	Auto Body	Ind. Arts	Draft.	Const.	Metals	Heal. Occ.	Food Ser.	Elec.	Elec- tromec.	Comm. Art	Graph. Arts	Agri- Occ.
1. Describes Atomic nature of matter	X	X	X		X	X			X	X			X
2. Describes forms of energy	X	X	X		X	X	X		X	X			X
3. Interprets matter-energy relations	X		X		X	X			X	X			X
4. Identifies Forces			X	X					X	X			X
5. Measures Forces			X						X	X			X
6. Solves Density Prob.							X						
7. Conserves Mass, Area and Volume													
8. Classifies with Several Dichotomies													
9. Describes the Life Requirements							X	X					X
10. Compares States of Matter							X	X				X	X
11. Cause/Effects on the Environment							X						X
12. Describes cycles and Phases in Nature													X
13. Infers cause/effect of weather													
14. Models Data							X		X				X
15. Interprets Data							X		X				X
16. Describes Cellular Nature of Org.							X						X
17. Compares Plants and Animals							X	X					X
18. Interprets Water, CO and Nit. Cycles													X
19. Predicts Pop. Futures													X
20. Designs Fair Tests For Phenomena													
21. Compares Chemical/Physical Changes	X		X		X		X	X		X	X		X
22. Interprets Systems, Organs and Tissues							X						X
23. Infers and Hypothes.													X

SUGGESTED MODELS RELATED TO SCIENCE AND MATHEMATICS
CREDIT REQUIREMENTS

INTRODUCTION:

The models suggested here are presented as ways to lessen the impact and competition of increased course requirements in science and mathematics. Some care has been taken to avoid the following:

- Awarding dual credit in an academic area and vocational area for the same time allotment.
- Indication that additional courses are unimportant and that schools should stress only one area.
- Indication that experience in vocational courses alone will meet all the requirements of science and mathematics students.

The models are based on the suggested essential skills identified in this study. These skills are taught in introductory courses of chemistry, physics and biology. The essential mathematics skills would be completed by the time students complete Algebra I for the most part. They must be considered as minimal in the academic areas.

If the skills are "essential" as many educators believe, there is certainly less need to add more course requirements in science and mathematics. Where these skills are coded to applied areas like vocational education, there is even more assurance that these skills are being applied and maintained. The models offer diversity and several options for the local education agencies to consider. The need for a balanced comprehensive high school program should be emphasized.

OPTION 1 - Direct Credit for Vocational Courses.

Examples:

A. Science Courses

1. Principles of technology
2. Electronics
3. Electromechanics
4. Health Occupations

(OPTION 1 continued)

3. Mathematics Courses

1. Business mathematics
2. Accounting
3. Math of finance industry
4. Consumer mathematics

OPTION 2 - Shared Credits for Vocational Courses.
($\frac{1}{2}$ Academic - $\frac{1}{2}$ Vocational)

Examples:

A. Science Courses

1. Combination of any two of these courses for a combined 1 unit in science and $\frac{1}{2}$ unit in each of the two vocational courses.

- | | |
|---------------------|-----------------------|
| a. electronics | d. horticulture |
| b. electromechanics | e. automechanics |
| c. Voc. Agric. | f. health occupations |
| | g. industrial arts |

B. Mathematics Courses

1. Combination of any two of these courses for a combined 1 unit in mathematics and $\frac{1}{2}$ unit in each of the two vocational courses.

- | | |
|---------------------|-----------------------|
| a. auto mechanics | e. metals |
| b. construction | f. health occupations |
| c. electronics | g. commercial art |
| d. electromechanics | h. industrial art |

OPTION 3 - Competency testing in lieu of credits required:

Using suggested essential skills tests to establish competency at that level so that one or both courses could be deleted or reduced.

OPTION 4 - Request policy change at the local district to reduce established credit requirements based on the coded skills, tests, demonstrated occupational needs for students, national trends, state trends and requirements. The codings, tests and trends give local educators some outside support for this position.

OPTION 5 - Adoption or adaptation of a successful model from exemplary programs in other districts. Some examples are included in this report. Others are felt to be available. These need to be identified and made available

RECOMMENDATIONS

1. Disseminate to all Colorado Districts:
 - a. Suggested lists of science and mathematics essential skills with a cover letter to indicate availability of the competency tests and course codings.
 - b. An abstract of this study listing findings and recommendations.
 - c. Models and options for credit requirements.
2. Collect from Appropriate and Selected Districts:
 - a. Additional exemplary models for:
 1. substituting credit in science and mathematics
 2. sharing credits in science and mathematics
 3. awarding credits by competency testing
 4. reduced academic credits by illustration of essential in vocational courses.
 5. other models by which enrollment in vocational education is being maintained or is increasing.
3. Report and discuss the research findings at scheduled regional and state meetings as a major agenda item.
4. Use the questionnaire established by the 1986 study as a basis for annual analysis of the academic course requirements and enrollment impact on vocational education.
5. Identify and establish pilot schools where the tests can be used and validated.
6. Seek acceptance and support for the suggested essential skills from:
 - a. The Colorado Department of Education
 - b. Science and Mathematics Specialists and Teachers
 - c. High School Principals
 - d. Vocation Educational Directors and Teachers

PLAN OF ACTION FOR SBCCOE

FALL 1986:

1. Prepare a dissemination package for local districts to include the essential skills list for science and mathematics, summary of the models (options) an abstract of this study and the availability of the tests and codings to vocational courses.
2. Identify 2-5 pilot schools to validate the science and mathematics criterion tests for essential skills in science and mathematics.
3. Seek support for the essential skills from State Department of Education, science and mathematics educators and from vocational educators.

Winter-Spring 1986-1987 :

1. Present the study's findings at scheduled meetings.
2. Conduct a follow-up using the FY 1986 questionnaire to study enrollment trends.
3. Continue support for acceptance of the essential skills from decision making groups.
4. Study employment demands for students in vocational areas.
5. Request districts to report exemplary practice to maintain and increase enrollment in vocational courses.

Spring 1987:

1. Analyze the two year trend results from the questionnaire
2. Summarize the P values for items from the criteria tests.
3. Summarize the exemplary practice data for increasing enrollment.

Summer 1987:

1. Plan agenda items for fall meetings to include the enrollment trends, exemplary practice listings and test validation.

APPENDIX A

REVIEW OF RELATED LITERATURE

Very little quantitative data has been used or collected with regard to the setting up of requirements for additional science and mathematics high school courses. Public opinion seems to be the change agent. Widely read reports such as, A Nation At Risk, and reports from national, state and local task forces emphasize the following in almost all their recommendations:

- Education must become a high priority in America.
- American education must become the best in the world.
- School improvement in science and mathematics is targeted as a high priority area.
- Additional course requirements is the methodology to accomplish these new priorities.

The 1984 Gallop Poll reported that the general public believes that 96% of students who enter college should have math required and 92% believe that even students who are not college bound should study math. This was true even though many of the participants in the poll did not either like mathematics or choose mathematics as an elective in either high school or college.

There was general agreement on the importance and support of basic requirements for both science and mathematics. There seems to be great commitment to additional courses without specifying what skills the courses are to develop. The essential skills are apparently assumed to be mastered by exposure and completion of the required courses.

Curriculum guides and standards for 34 states were reviewed for mathematics skills. 31 states had curriculum guides or standards for science. Where these guides or standards indicated minimal or essential skills, they were included to help establish the suggested list of skills from this study.

The literature search seemed to indicate that the national demand for excellence in education and the accountability movement initiated in the early 1970s resulted in a surge of additional requirements at the state level between 1974-1984 where 40 of the 50 states increased math requirements and most of this number also increased science requirements. The stability between 1984-1986, established by a survey of this study, indicates that the changes occurring at present are at the local level. While there will be more alternatives possible for local education agencies to adopt, the public expectations and belief that education is improving are still tied to

traditional action where courses are added.

References listed do not include all the guides, standards and bulletins from The State Department of Education. These were reviewed as part of the literature search.

Standardized tests commonly used in the schools were also reviewed. Since these tests are well accepted by both educators and the general public it was felt they should be used in the generation of essential skills lists. Representative tests were included as authority groups in listing the skills.

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APPENDIX B

6925 South Clermont Drive
Littleton, Colorado 80122
April 24, 1986

TO: State Science and Mathematics Supervisors

FROM: Glyn H. Sharpe

Glyn H. Sharpe

SUBJECT: Request for information concerning trends and effects of graduation requirements.

I am seeking your assistance to provide some brief answers to the attached survey concerning science and mathematics required at the state levels. The research is sponsored by the Colorado Department of Education and hopefully will not take much of your time to complete.

A number of Colorado local schools have increased both science and mathematics requirements during the last few years raising concerns and fears in other areas. The vocational people at the state level are very concerned in that their job placement seems to be almost 100% while their enrollment seems to be declining. There are similar concerns in other areas and we are trying to get a limited view of the national picture.

If a summary of the survey might be of some use to you, I will be happy to share this with you. Please check yes for question #7 on the survey form. The study should be completed by June 30, 1986.

It was my pleasure to work some with both of your groups and you need to know how very much I enjoyed that. I hope to visit with many of you in the near future. I hope you are having a good year and your help in completing the survey will be most appreciated.

STATE REQUIREMENTS AND STANDARDS
FOR MATHEMATICS

STATE _____

REPORTER _____

ADDRESS _____

TELEPHONE _____

Please check the appropriate space that applies to your state:

1. Mathematics requirements for high school graduation that are state mandated is:

a. _____ none, b. _____ one year, c. _____ two years, d. _____ three years
or e. _____ four years.

2. Does your state require students to pass a statewide mathematics test as part of
the graduation requirements? a. _____ yes or b. _____ no

3. Graduation requirements in mathematics, if any, are met by: a. _____ courses
completed, b. _____ competency testing statewide, c. _____ competency
testing local or d. _____ teacher verification or judgement.

4. Can other programs that apply mathematics like some vocational courses be used
to meet one or more of the mathematics requirements? a. _____ yes or b. _____ no.

If yes, which of the following are used?

a. _____ Other area courses are substituted for a mathematics requirement.

b. _____ Credit is partially shared between mathematics and the other area.

c. _____ Other (please specify) _____

5. Has your state increased the mathematics requirements in the past three years?

a. _____ yes or b. _____ no.

6. Does your state have essential skills for high school graduation?

a. _____ yes or b. _____ no.

7. A summary of this survey is requested. a. _____ yes or b. _____ no.

* The science questionnaire was identical questions.

APPENDIX C

ENTRY-EXIT TEST FOR VOCATIONAL STUDENTS MATHEMATICS TASKS AND TOPICS INCLUDED *

A. COMPUTATIONAL SKILLS:

1. Adding whole numbers.....Items 1-4
2. Adding fractional numbers.....Items 5-8
3. Adding decimal numbers.....Items 9-12
4. Subtracting whole numbers.....Items 13-16
5. Subtracting decimal numbers.....Items 17-20
6. Subtracting fractional numbers.....Items 21-24
7. Multiplying whole numbers.....Items 25-28
8. Multiplying decimal numbers.....Items 29-32
9. Dividing whole numbers.....Items 33-36
10. Dividing decimal numbers.....Items 37-40

B. CONCEPTUAL SKILLS

11. Converting fractions to decimals.....Items 41-44
12. Converting fractions to percents.....Items 45-48
13. Converting decimals to percents.....Items 49-52
17. Constructing equivalent fractions (proportions).....Items 65-68
18. Determining ratios.....Items 69-72
20. Rounding numbers.....Items 77-80

C. APPLIED SKILLS

14. Measuring perimeter.....Items 53-56
15. Measuring volume.....Items 57-60
16. Measuring area.....Items 61-64
19. Measuring Temperature.....Items 73-76
21. Averaging numbers.....Items 81-84
22. Interpreting data.....Items 85-88

* There are four multiple choice items for each skill. It is suggested to accept 3 or 4 correct responses as an indication of mastery for that skill.

ANSWERS TO ENTRY-EXIT MATHEMATICS TEST

1. C	30. J	59. C	88. C
2. F	31. B	60. K	<u>End of answers</u>
3. E	32. K	61. C	
4. G	33. A	62. H	
5. B	34. K	63. B	
6. H	35. D	64. J	
7. E	36. G	65. E	
8. G	37. B	66. G	
9. D	38. K	67. D	
10. K	39. B	68. G	
11. A	40. H	69. A	
12. K	41. C	70. H	
13. A	42. F	71. C	
14. K	43. E	72. G	
15. C	44. K	73. C	
16. H	45. D	74. F	
17. C	46. G	75. A	
18. J	47. A	76. K	
19. B	48. J	77. D	
20. K	49. C	78. G	
21. B	50. J	79. D	
22. J	51. B	80. K	
23. B	52. F	81. D	
24. J	53. D	82. G	
25. C	54. F	83. B	
26. F	55. D	84. K	
27. D	56. G	85. A	
28. H	57. E	86. J	
29. E	58. F	87. C	

ENTRY-EXIT TEST - VOCATIONAL MATHEMATICS

DIRECTIONS TO THE STUDENTS:

Each problem in this booklet has five suggested answers. Read each problem carefully. Work the problem on scratch paper. Decide which answer is correct. Make a dark mark that fills the space on the answer card which has the same letter as the answer you chose. If you wish to change your answer, erase your first answer completely. DO NOT MARK more than one answer for any problem. Record all of your answers on the answer card.

DO NOT WRITE IN THIS TEST.Find the Sum in 1-4

1. $12 + 8 =$

A. 30

B. 4

C. 20

D. 8

E. 96

2. 235

142

+ 623

F. 1000

G. 999

H. 980

J. 990

K. 1001

3. 26

42

39

17

+ 78

A. 149

B. 820

C. 203

D. 102

E. 202

4. 326

184

+ 566

F. 976

G. 1076

H. 1066

J. 1266

K. 1170

GO ON TO THE NEXT PAGE

Add the Fractions

5. $\frac{1}{2} + \frac{2}{3} =$

- A. $\frac{3}{5}$
B. $\frac{7}{6}$ or $1\frac{1}{6}$
C. $\frac{3}{6}$
D. $\frac{9}{6}$ or $1\frac{1}{2}$
E. $\frac{8}{6}$ or $1\frac{1}{3}$

6. $\frac{5}{8} + \frac{3}{4} =$

- F. $\frac{11}{32}$
G. $\frac{1}{8}$
H. $\frac{11}{8}$ or $1\frac{3}{8}$
J. $\frac{8}{12}$
K. $\frac{1}{3}$

7. $\frac{3}{4} + \frac{1}{2} =$

- A. $\frac{3}{8}$
B. $\frac{4}{6}$
C. $\frac{9}{8}$ or $1\frac{1}{8}$
D. $\frac{4}{5}$
E. $\frac{5}{4}$ or $1\frac{1}{4}$

8. $\frac{5}{8} + \frac{1}{2} =$

- F. $\frac{5}{16}$
G. $\frac{9}{8}$ or $1\frac{1}{8}$
H. $\frac{6}{10}$
J. $\frac{8}{9}$
K. $\frac{3}{4}$

Add the Decimals

9. $8.2 + 2.14 + 3.45 =$

- A. 12.83
B. 14.69
C. 12.79
D. 13.79
E. 137.90

10. 23.46

$$\begin{array}{r} 23.46 \\ 5.89 \\ + .083 \\ \hline \end{array}$$

- F. 235.433
G. 30.18
H. 29.035
J. 2.903
K. 29.433

GO ON TO THE NEXT PAGE

$$\begin{array}{r} 11. \ \$ \ 2.63 \\ \ 12.14 \\ + \ 3.89 \\ \hline \end{array}$$

- A. \$13.66
- B. \$18.76
- C. \$19.66
- D. \$136.60
- E. \$203.40

$$\begin{array}{r} 12. \ \$ \ 3.45 \\ \ 6.23 \\ + \ 3.34 \\ \hline \end{array}$$

- F. \$13.42
- G. \$1.342
- H. \$9.68
- J. \$10.07
- K. \$13.52

Subtract the Whole Numbers

$$13. \ 39 - 14 =$$

- A. 25
- B. 35
- C. 16
- D. 53
- E. 52

$$\begin{array}{r} 14. \ 263 \\ - 143 \\ \hline \end{array}$$

- F. 506
- G. 32
- H. 12
- J. 406
- K. 120

$$\begin{array}{r} 15. \ 3489 \\ - 1639 \\ \hline \end{array}$$

- A. 5128
- B. 1950
- C. 1850
- D. 2050
- E. 2250

$$\begin{array}{r} 16. \ 3724 \\ - 2985 \\ \hline \end{array}$$

- F. 6709
- G. 7390
- H. 739
- J. 67,090
- K. 5385

Subtract the Decimals

$$\begin{array}{r} 17. \ \$ \ 23.14 \\ - \ 1.85 \\ \hline \end{array}$$

- A. \$ 2.129
- B. \$22.71
- C. \$21.29
- D. \$24.99
- E. \$20.29

$$18. \ 326.4 - 5.03 =$$

- F. 336.1
- G. 32.137
- H. 34.143
- J. 321.37
- K. 376.1

GO ON TO THE NEXT PAGE

19. $\begin{array}{r} \$ 26.49 \\ - 14.23 \\ \hline \end{array}$

- A. \$40.72
- B. \$12.26
- C. \$14.85
- D. \$2.26
- E. \$13.14

20. $\begin{array}{r} \$ 35.42 \\ - 17.61 \\ \hline \end{array}$

- F. \$18.81
- G. \$5.303
- H. \$178.1
- J. \$53.03
- K. \$17.81

Subtract the Fractions

21. $\frac{5}{8} - \frac{1}{4} =$

- A. $\frac{3}{4}$
- B. $\frac{3}{8}$
- C. $\frac{3}{2}$ or $1 \frac{1}{2}$
- D. $\frac{1}{2}$
- E. $\frac{1}{8}$

22. $\frac{1}{2} - \frac{1}{3} =$

- F. $\frac{1}{5}$
- G. $\frac{1}{2}$
- H. $\frac{1}{3}$
- J. $\frac{1}{6}$
- K. $\frac{1}{4}$

23. $\frac{3}{7} - \frac{1}{4} =$

- A. $\frac{2}{11}$
- B. $\frac{5}{28}$
- C. $\frac{4}{11}$
- D. $\frac{2}{3}$
- E. $\frac{19}{28}$

24. $\frac{5}{9} - \frac{1}{3} =$

- F. $\frac{1}{3}$
- G. $\frac{5}{27}$
- H. $\frac{6}{12}$ or $\frac{1}{2}$
- J. $\frac{2}{9}$
- K. $\frac{1}{9}$

Multiply the Whole Numbers

25. $23 \times 16 =$

- A. 39
- B. 7
- C. 368
- D. 36.8
- E. 268

26. $16 \times 19 \times 8 =$

- F. 2,432
- G. 280
- H. 2,434
- J. 43
- K. 1,824

27. $\begin{array}{r} 3458 \\ \times 163 \\ \hline \end{array}$

- A. 563.354
- B. 3,514
- C. 5,633,540
- D. 563,654
- E. 3,611

28. $\begin{array}{r} 3218 \\ \times 173 \\ \hline \end{array}$

- F. 3,391
- G. 55,671.4
- H. 556,714
- J. 555,714
- K. 3,045

Multiply the Following Decimals

29. $\begin{array}{r} 16.1 \\ \times 2.3 \\ \hline \end{array}$

- A. 18.4
- B. 13.8
- C. 28.03
- D. 27.03
- E. 37.03

30. $16.17 \times 1.2 =$

- F. 16.37
- G. 194.04
- H. 20.404
- J. 19.404
- K. 16.35

31. $\begin{array}{r} 16.23 \\ \times 7.4 \\ \hline \end{array}$

- A. 12.1020
- B. 120.102
- C. 130.103
- D. 12.01202
- E. 23.63

32. $\begin{array}{r} 21.31 \\ \times 6.8 \\ \hline \end{array}$

- F. 27.11
- G. 15.51
- H. 149.41
- J. 14,491
- K. 144.908

Divide the Whole Numbers

33. $4 \overline{)324} =$

- A. 31
- B. 71
- C. 8.1
- D. 810
- E. 328

34. $\frac{112}{14} =$

- F. 80
- G. 6
- H. 7
- J. 18
- K. 8

GO ON TO THE NEXT PAGE

35. $132 \overline{)10296} =$

- A. 10,428
- B. 7.8
- C. 68
- D. 78
- E. 780

36. $142 \overline{)16,046} =$

- F. 123
- G. 113
- H. 1130
- J. 1230
- K. 11.3

Divide the Decimals

37. $\frac{6.4}{.8} =$

- A. 80
- B. 8
- C. .8
- D. 18
- E. 7.2

38. $.14 \overline{)2.24} =$

- F. .16
- G. 14
- H. 2.38
- J. 1.43
- K. 16

39. $45.6 \overline{)145.92} =$

- A. 1.6
- B. 3.2
- C. 6.4
- D. 32
- E. 320

40. $14.3 \overline{)91.52} =$

- F. 8.9
- G. 3.2
- H. 6.4
- J. 164
- K. 64

41. Write $\frac{1}{4}$ as a decimal.

- A. .40
- B. 25
- C. .25
- D. .10
- E. 2.5

42. $\frac{3}{4}$ names which decimal?

- F. .75
- G. .76
- H. .8
- J. .7
- K. 7.5

43. What is $\frac{7}{8}$ as a decimal?

- A. .70
- B. 82.5
- C. 8.75
- D. .80
- E. .875

44. What is $\frac{3}{5}$ as a decimal?

- F. .40
- G. .20
- H. .80
- J. .70
- K. .60

45. What is $\frac{1}{4}$ as a percent?

- A. 14%
- B. 33%
- C. 40%
- D. 25%
- E. 41%

46. Write $\frac{3}{4}$ as a percent.

- F. 30%
- G. 75%
- H. 40%
- J. 25%
- K. 34%

47. Change $\frac{3}{5}$ to a percent.

- A. 60%
- B. 30%
- C. 35%
- D. 80%
- E. 50%

48. Change $\frac{3}{2}$ to a percent.

- F. $\frac{3}{2}\%$
- G. 60%
- H. 70%
- J. 150%
- K. 80%

49. Change .375 to a percent.

- A. .375%
- B. 3.75%
- C. 37.5%
- D. 3750%
- E. 375%

50. What is .875 in percent?

- F. 875%
- G. 3750%
- H. .875%
- J. 87.5%
- K. 8.75%

51. What is 2.3 in percent?

- A. 2.3%
- B. 230%
- C. 023%
- D. .23%
- E. 23%

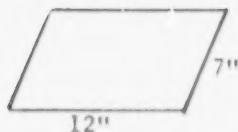
52. What is 3.2 in percent?

- F. 320%
- G. 32%
- H. 3.2%
- J. $\frac{32}{100}$
- K. $\frac{32}{1000}$

53. What is the perimeter of a rectangle whose length is 9 inches and whose width is 5 inches?

- | | |
|--------------|--------------|
| A. 45 inches | D. 28 inches |
| B. 14 inches | E. 56 inches |
| C. 90 inches | |

54. Find the perimeter.



F. 38"

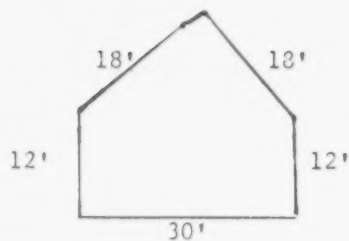
J. 84"

G. 19"

K. 24"

H. 168"

55. Find the perimeter.



A. 66'

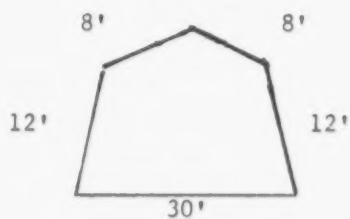
D. 90'

B. 72'

E. 60'

C. 102'

56. Find the perimeter.



F. 90'

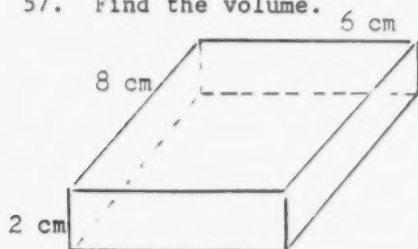
J. 60'

G. 70'

K. 80'

H. 140

57. Find the volume.



A. 16 cm³

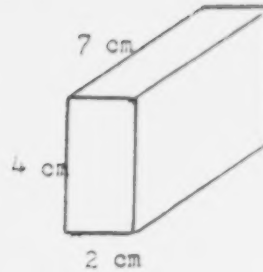
D. 12 cm³

B. 48 cm³

E. 96 cm³

C. 12 cm³

58. Find the Volume.



F. 56 cubic feet

J. 26 cubic feet

G. 3 cubic feet

K. 14 cubic feet

H. 28 cubic feet

59. What is the volume of a rectangular solid whose length is 6 inches width of 4 inches and height of 4 inches?

A. 44 cubic inches

B. 30 cubic inches

C. 96 cubic inches

D. 24 cubic inches

E. 48 square inches

60. What is the volume of a rectangular solid whose length is 6 inches width of 3 inches and height of 6 inches?

F. 24 cubic inches

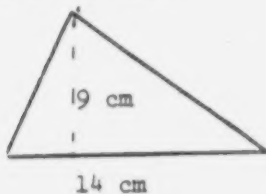
G. 30 cubic inches

H. 17 cubic inches

J. 24 cubic inches

K. 180 cubic inches

61. Find the area.



A. 126 cm^2

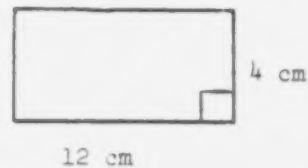
D. 14 cm^2

B. $31 \frac{1}{2} \text{ cm}^2$

E. 72 cm^2

C. 63 cm^2

62. Find the area of the rectangle.



F. 25 cm^2

J. 48 cm^2

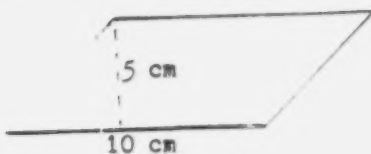
G. 16 cm^2

K. 32 cm^2

H. 48 cm^2

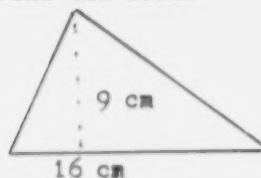
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63. Find the area.



- A. 25 cm² D. 60 cm²
 B. 50 cm² E. 32 cm²
 C. 30 cm²

64. Find the area.



- F. 144 cm² J. 72 cm²
 G. 50 cm² K. 50 cm³
 H. 50 cm

65. $\frac{3}{4} = \frac{9}{?}$

- A. 4
 B. 10
 C. 8
 D. 16
 E. 12

66. Which set shows 3 equivalent names for $\frac{7}{8}$?

- F. $(\frac{21}{24}, \frac{56}{49}, \frac{72}{63})$ J. $(\frac{28}{40}, \frac{42}{56}, \frac{21}{24})$
 G. $(\frac{28}{32}, \frac{14}{16}, \frac{56}{64})$ K. $(\frac{42}{48}, \frac{56}{64}, \frac{28}{32})$
 H. $(\frac{21}{32}, \frac{35}{40}, \frac{49}{56})$

67. Which fraction is equivalent to $\frac{7}{8}$?

- A. $\frac{3}{4}$ D. $\frac{21}{24}$
 B. $\frac{7}{16}$ E. $\frac{15}{16}$
 C. $\frac{21}{32}$

68. Which fraction is equivalent to $\frac{5}{7}$?

- F. $\frac{15}{14}$ J. $\frac{20}{35}$
 G. $\frac{10}{14}$ K. $\frac{10}{21}$
 H. $\frac{7}{5}$

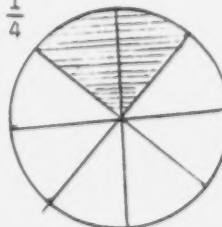
69. What ratio is shown by the shaded parts?

- A. $\frac{3}{7}$ D. $\frac{3}{4}$
 B. $\frac{1}{2}$ E. $\frac{5}{7}$
 C. $\frac{1}{4}$



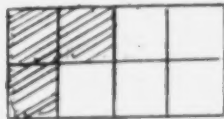
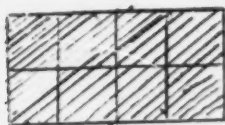
70. What ratio is shown by the shaded part?

- F. $\frac{2}{5}$ J. $\frac{1}{3}$
 G. $\frac{2}{4}$ K. $\frac{2}{5}$
 H. $\frac{1}{4}$



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71. What ratio is shown by the shaded parts?



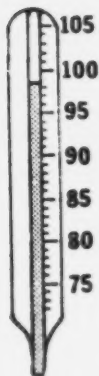
- A. $\frac{3}{8}$
 B. $1\frac{5}{8}$
 C. $1\frac{3}{8}$
 D. $\frac{10}{3}$
 E. $1\frac{3}{5}$

72. What ratio is shown by the shaded parts?



- F. $1\frac{3}{5}$
 G. $1\frac{1}{2}$
 H. $\frac{1}{2}$
 J. $2\frac{1}{2}$
 K. $\frac{9}{12}$

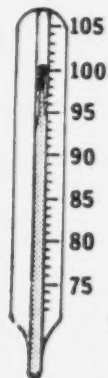
73. Look at the thermometer below.



What temperature does the thermometer show?

- A. 100.6° F
 B. 99.2° F
 C. 98.6° F
 D. 101.4° F
 E. 99.3° F

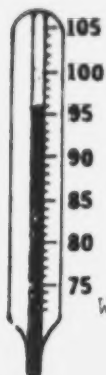
74. Look at the thermometer below.



What temperature does the thermometer show?

- F. 100.6° F
 G. 99.2° F
 H. 98.6° F
 J. 101.4° F
 K. 99.3° F

75. Look at the thermometer below.



What temperature does it show?

- A. 96° F
 B. 95° F
 C. 89° F
 D. 94° F
 E. 97° F

76. Look at the thermometer below.



What temperature does it show?

- F. 96° F
 G. 95° F
 H. 89° F
 J. 94° F
 K. 97° F

77. 14 rounded to the nearest 10 is?

- | | |
|--------|--------|
| A. 140 | D. 10 |
| B. 14 | E. 100 |
| C. 0 | |

78. 1.6 rounded to the nearest whole number is?

- | | |
|-------|--------|
| F. 1 | J. 0 |
| G. 2 | K. 100 |
| H. 10 | |

79. 150 rounded to the nearest hundred is?

- | | |
|--------|--------|
| A. 300 | D. 200 |
| B. 10 | E. 1.5 |
| C. 100 | |

80. 3520 rounded to the nearest thousand is?

- | | |
|---------|---------|
| F. 3000 | J. 3500 |
| G. 2000 | K. 4000 |
| H. 1000 | |

What is the average of these numbers?

81. 15, 16, 17, 18

- | | |
|-------|---------|
| A. 15 | D. 16.5 |
| B. 16 | E. 17.5 |
| C. 17 | |

82. 21, 24, 32, 47

- | | |
|-------|---------|
| F. 32 | J. 24 |
| G. 31 | K. 26.5 |
| H. 30 | |

83. 17.2, 18.3, 20.6

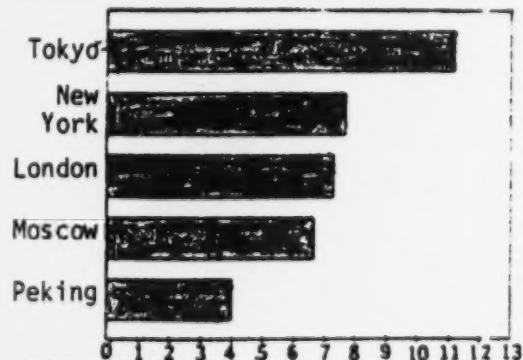
- | | |
|---------|-------|
| A. 17.2 | D. 18 |
| B. 18.7 | E. 19 |
| C. 18.3 | |

84. 120, 238, 380

- | | |
|--------|--------|
| F. 780 | J. 240 |
| G. 250 | K. 246 |
| H. 238 | |

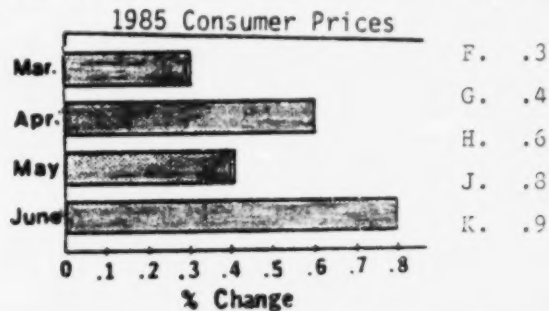
85. In 1980 which two cities had a population between 7 and 8 million?

- | |
|------------------------|
| A. New York and London |
| B. Tokyo and New York |
| C. London and Moscow |
| D. Tokyo and Peking |
| E. Moscow and New York |

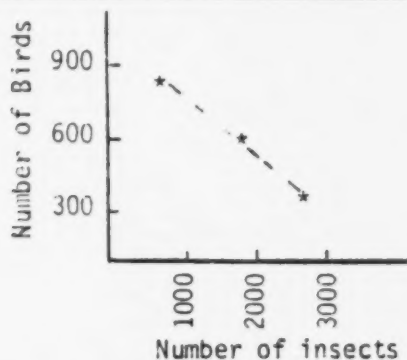


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86. According to this graph, what was the percent change in consumer prices in June?



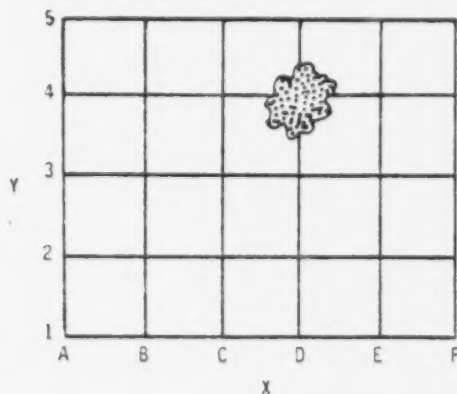
87.



According to this graph, which is true?

- A. More birds mean more insects.
- B. Fewer birds mean fewer insects.
- C. More birds mean fewer insects.
- D. More birds mean the same insects.
- E. The same insects mean the same birds.

88. Look at the map.



The lake is located at ____, ____.

- A. C, 4
- B. D, 4
- C. D, 4
- D. D, 3

STOP

SUGGESTED ENTRY-EXIT TEST FOR VOCATIONAL STUDENTS
SCIENCE TASKS AND TOPICS INCLUDED IN THE TEST

A. CONCEPTUAL SKILLS:

- 1. Describes the atomic nature of matter Items 1-4
- 2. Describes forms of energy Items 5-8
- 4. Identifies forces Items 13-16
- 9. Describes the life requirements Items 33-36
- 12. Describes cycles and phases in nature Items 45-48

B. PROCESS SKILLS:

- 3. Interprets matter-energy relations Items 9-12
- 5. Measures forces Items 17-20
- 6. Solves density problems Items 21-24
- 8. Classifies using several dichotomies Items 29-32
- 10. Compares states of matter Items 37-40
- 14. Models data Items 53-56
- 15. Interprets data Items 57-60
- 17. Compares plants and animals Items 65-68
- 18. Interprets the water, carbon dioxide and nitrogen cycles Items 69-72
- 21. Compares chemical and physical changes Items 81-84
- 22. Interprets systems, organs and tissues Items 85-88

C. PROBLEM SOLVING SKILLS:

- 7. Conserves mass, area and volume Items 25-28
- 11. Predicts cause/effects on the environment Items 41-44
- 13. Infers cause/effects of weather Items 49-52
- 19. Predicts population futures Items 73-76
- 20. Designs fair tests for phenomena Items 77-80
- 23. Makes inferences and hypotheses Items 89-92

*There are four multiple choice items for each skill. It is suggested to accept 3 or 4 correct responses as an indication of mastery for that skill.

ANSWERS TO ENTRY-EXIT SCIENCE TEST

1. C	28. J	55. A	82. J
2. F	29. A	56. J	83. C
3. B	30. K	57. D	84. H
4. J	31. D	58. G	85. D
5. E	32. G	59. B	86. G
6. G	33. D	60. G	87. A
7. D	34. G	61. B	88. G
8. J	35. B	62. H	89. C
9. C	36. G	63. D	90. H
10. F	37. B	64. G	91. B
11. E	38. H	65. C	92. G
12. K	39. E	66. G	
13. C	40. G	67. D	
14. F	41. D	68. H	
15. C	42. H	69. E	
16. G	43. B	70. J	
17. C	44. J	71. D	
18. K	45. D	72. F	
19. A	46. H	73. B	
20. K	47. C	74. F	
21. C	48. F	75. D	
22. G	49. E	76. G	
23. C	50. K	77. A	
24. F	51. D	78. H	
25. C	52. J	79. B	
26. G	53. E	80. K	
27. C	54. H	81. B	

ENTRY-EXIT TEST - VOCATIONAL SCIENCE

DIRECTIONS TO THE STUDENTS:

Each problem in this booklet has five suggested answers. Read each problem carefully. Decide which answer is correct. Make a dark mark that fills the space on the answer card which has the same letter as the answer you chose. If you wish to change your answer, erase your first answer completely. DO NOT MARK more than one answer for any problem.

Record all of your answers on the answer card.

DO NOT WRITE in this test.

1. The simplest part of a substance is?
 - A. an ion
 - B. an atom
 - C. a molecule
 - D. a proton
 - E. a neutron
2. The simplest part of an element is?
 - F. an atom
 - G. an ion
 - H. a molecule
 - J. a proton
 - K. a neutron
3. The nucleus of all atoms contain?
 - A. molecules
 - B. protons
 - C. electrons
 - D. ions
 - E. photons
4. All of these statements except ____ are true.
 - F. molecules have one or more atoms.
 - G. the simplest atom is hydrogen.
 - H. protons are much more massive than electrons.
 - J. Electrons have a positive charge.
 - K. Protons and neutrons are found in the atom's nucleus.

5. Friction produces?

- A. electricity
- B. sound
- C. light
- D. magnetism
- E. heat

6. Vibration produces?

- F. electricity
- G. sound
- H. light
- J. magnetism
- K. heat

7. Stored energy is?

- A. kinetic energy
- B. dynamic energy
- C. electricity
- D. potential energy
- E. energy in motion

8. Energy from the sun is?

- F. potential energy
- G. electrical energy
- H. Lunar energy
- J. solar energy
- K. nuclear energy

9. All these changes except ? release heat.

- A. volcanic eruptions
- B. electrical currents in wire
- C. tidal waves
- D. Burning
- E. explosions

10. When substances change from gases to a liquid state, which of these is true?

- F. Heat is taken out of the gas.
- G. Heat is absorbed by the gas.
- H. The heat is not changed.
- J. The volume of the gas increases.
- K. The temperature of the gas increases.

11. Substances can gain potential energy by which of these changes?

- A. explosions
- B. earthquakes
- C. volcanoes
- D. change of position from the top to the bottom of a hill.
- E. change of position from the bottom to the top of a hill.

GO ON TO THE NEXT PAGE

12. Which of these almost completely converts matter to energy?

- F. electrical production
- G. light bulbs
- H. physical change of state
- J. chemical change
- K. nuclear reaction

13. The unit of electrical force is which of these?

- A. ergs
- B. amps
- C. volts
- D. ohms
- E. watts

14. What kind of force causes objects to fall towards the earth?

- F. gravitational
- G. electrical
- H. mechanical
- J. magnetic
- K. nuclear

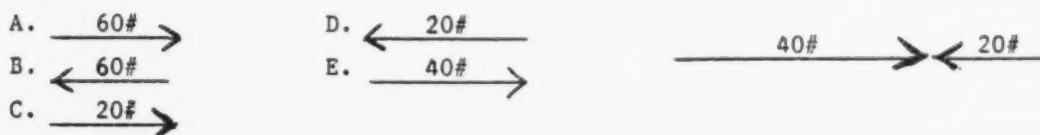
15. All except ? are true statements about forces.

- A. forces can do work.
- B. forces can give mechanical advantage.
- C. forces are a form of energy.
- D. forces can change direction of something.
- E. forces are pushes and pulls.

16. Satelites are held in place by which of these forces?

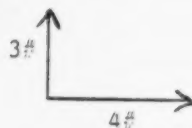
- F. optical force
- G. centrifugal force
- H. nuclear force
- J. electrical force
- K. magnetic force

17. The resultant force shown by this diagram is ?



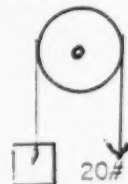
18. The resultant force shown by this diagram is which of these forces?

- F. 3# ↑
- G. 5# →
- H. 4# →
- J. 5# ↙
- K. 5# ↗



19. The resultant action shown by the following diagram is which of these?

- A. 20# ↑
- B. 20# ↓
- C. no action
- D. 40# ↑
- E. 40# ↓



20. The resultant force for this diagram shown is zero; what force does the box represent.

- F. 30#
- G. 30#
- H. 120#
- J. 60#
- K. 60#



21. To measure density we must know the mass and the _____ ?

- A. state of matter
- B. shape
- C. volume
- D. surface tension
- E. kind of material

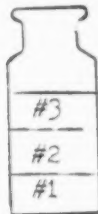
22. Pure water has a density of which of these?

- F. .99
- G. 1
- H. 0
- J. -1
- K. 100

GO ON TO THE NEXT PAGE

23. If something floats in water its density is?

- A. 1
- B. more than 1
- C. less than 1
- D. .5
- E. 2



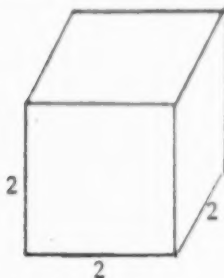
24. The diagram shows how three liquids looked in a container. What is true about liquid #3?

- F. It has the least density
- G. It has the greatest density
- H. Liquids #2 and #1 have the same density
- J. We cannot tell from the diagram
- K. It has greater density than water.

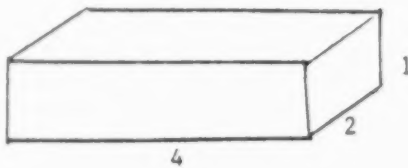
25. Volumes A and B have the same width.

Volume A has twice the height.

Volume B has twice the length.



A.



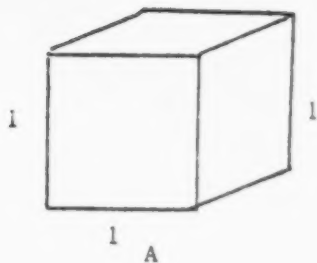
B.

Which of these is true?

- A. Volume A is greater than volume B.
- B. Volume B is greater than volume A.
- C. Volumes A and B are equal.
- D. The volumes cannot be determined.
- E. Taller objects have greater volumes.

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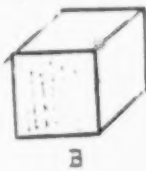
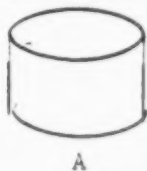
26.



Suppose Joe will let you pick apples until one container is full. Which container will you use to get the most apples?

- F. Cubic shapes hold fewer apples.
- G. I choose container A.
- H. I choose container B because the crate would stack better.
- J. I choose container B.
- K. I choose either container since they both hold the same number of apples.

27. Suppose you have two objects, A and B, and they have the same weight.

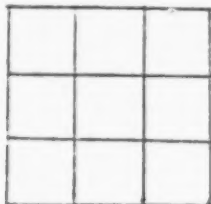


Which of these is true?

- A. They have the same volume.
- B. They do not have the same volume.
- C. They may have the same volume.
- D. They have the same surface area.
- E. They have the same shape.

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28. Sue, Maria and Ann were all given a square marked like this.



Sue and maria decided to cut their square to make figures like those below.
Ann left her square in the same shape that she received.



Sue's figure



Maria's figure

Which statement is correct?

- F. Bill said, "Ann's figure has the most area."
- G. Joe said, " Sue's figure has the most area. "
- H. Al said, "Maria's figure has the most area."
- J. Tom said, "All the areas are the same."
- K. Hank said, "None of the areas are the same."

Organs working together form systems. Some of the body organs are listed below. Which system do they belong to?

29. The Liver

- A. Digestive System
- B. Excretory System
- C. Nervous System
- D. Circulatory System
- E. Respiratory System

30. The Lungs

- F. Digestive System
- G. Excretory System
- H. Nervous System
- J. Circulatory System
- K. Respiratory System

GO ON TO THE NEXT PAGE

Mark the family name of the following characteristics that some of the animals have.

31. Warm blooded animal with feathers.

- A. Fish
- B. Reptile
- C. Insect
- D. Bird
- E. Mammal

32. Cold blooded animal with four legs.

- F. Fish
- G. Reptile
- H. Insect
- J. Bird
- K. Mammal

33. All the following except one is required by living animals, which is not required?

- | | |
|-----------|------------|
| A. food | D. friends |
| B. oxygen | E. water |
| C. energy | |

34. Plants need all these except one to sustain life. Which is not necessary to sustain life in plants?

- | | |
|-----------|-----------------------------|
| F. food | J. water |
| G. oxygen | K. disease free environment |
| H. energy | |

35. Which of the following is an essential life function of an organism?

- | | |
|-----------------|----------------|
| A. movement | D. white color |
| B. reproduction | E. exercise |
| C. green color | |

36. Bacteria is which kind of organism?

- | | |
|---------------|-------------|
| F. predator | J. consumer |
| G. decomposer | K. prey |
| H. producer | |

37. Water at room temperature is?

- | | |
|-------------|------------|
| A. a solid | D. plastic |
| B. a liquid | E. steam |
| C. a gas | |

GO ON TO THE NEXT PAGE

38. Which state of matter is most easily compressed?

- F. a solid
- G. a liquid
- H. a gas
- J. plastic
- K. ice

39. At forty degrees below zero, most materials are?

- A. gases
- B. plastics
- C. fluids
- D. liquids
- E. solids

40. As the temperature keeps rising most solids go through which of the stages shown?

- F. Liquid to solid to gases
- G. Solids to liquids to gases
- H. gases to liquids to solids
- J. No changes
- K. Solids to gases to liquids

41. Suppose the weather changes so that a desert that had the following annual rainfall changes as shown.

YEAR	ANNUAL RAINFALL
1980	7 in
1981	7 in
1982	6 in
1983	7 in
1984	85 in

If the 1984 rainfall continues for the next few years, which of these will probably not happen?

- A. there will be more plants.
- B. there will be more animals.
- C. Plants can be broad-leafed.
- D. The kind of plants and animals will be the same.
- E. The desert will become a rainforest.

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A farmer looked every day to see if the corn borer insect was in his fields. He tabulated this data.

Day	Number of insects/square yard
1	0
2	2
3	2
4	4
5	7
6	13

42. Which of these predictions is probably true?
- F. The insects have reached their peak.
 - G. There will be 9 insects on day 7.
 - H. Unless measures are taken, the insects may destroy the corn.
 - J. The borers will get tired of eating corn and leave.
 - K. On day 7 birds will come to eat the borers.
43. The farmer decides to spray with insecticide. Which of these effects will happen?
- A. The insecticide will kill every borer.
 - B. Some borers will survive.
 - C. The insecticide will not kill any insects.
 - D. It is sure to rain and wash off the insecticide.
 - E. The insects will not eat until the insecticide is washed off the corn.
44. If man's population is to increase, what probably must happen to these environments?
- F. The forests will increase.
 - G. The swamps will increase.
 - H. The grasslands will increase.
 - J. The farmland will increase.
 - K. The deserts will increase.

GO ON TO THE NEXT PAGE

45. Suppose you observe a community of organism where there are four distinct seasons. Your first observation is on a hot summer day; there are many trees, birds, insects and small animals in the area. When you come back it is winter, all but one of the following would probably be true.

- A. Many of the trees are no longer green.
- B. The number of birds is greater.
- C. There are no leaves on many trees.
- D. The grass is dead.
- E. Many birds left to find food elsewhere.

46. The stage of metamorphosis for insects that comes just before larvae is?

- | | |
|----------|-----------|
| F. worm | J. pupae |
| G. adult | K. larvae |
| H. egg | |

47. Some organisms live through periods when food is scarce by slowing down body functions. Which of these things is not an example of this?

- A. Hibernation of animals.
- B. Metamorphosis of insects.
- C. Migration of animals.
- D. recession of sap in plants.
- E. Plants lose leaves.

48. In the water cycle, the water evaporating from the earths surface goes through which of the following phases?

- F. evaporation - water in the air - precipitation - ground and underground water.
- G. evaporation - ground & underground water - precipitation.
- H. precipitation - clouds - underground water.
- J. clouds - rain - surface water.
- K. water in the air - rain - clouds.

49. All these factors except one cause weather changes.

- | | |
|-------------|----------------|
| A. winds | D. temperature |
| B. pressure | E. altitude |
| C. clouds | |

50. Which of these is most affected by relative humidity in the air?

- F. temperature
- G. pressure
- H. area
- J. volume
- K. precipitation

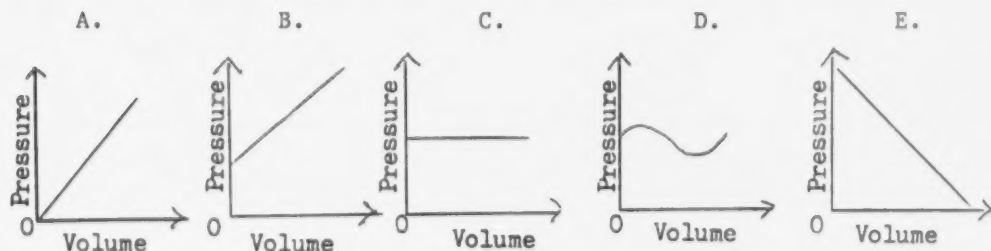
51. Which of these causes dew to form?

- A. warm moist air heats up at night
- B. the plants sweat
- C. it rained for a little while
- D. warm moist air cools at night
- E. cold dry air heats at night

52. Which of these changes cause stormy weather?

- F. rising pressure
- G. rising temperature
- H. cloud dissipation
- J. Decreasing pressure
- K. winds decreasing

53. Which graph shows decreasing volume as pressure increases?



54. What equation is represented by the table?

a	b
0	2
1	3
2	4
3	5
.	.
.	.

F. $a = b$

G. $a = b + 2$

H. $a + 2 = b$

J. $\frac{a}{b} = 2$

K. $a = \frac{b}{2}$

GO ON TO THE NEXT PAGE

55. Which table is represented by the equation, $a = b - 3$.

A.

a	b
0	3
1	4
2	5
3	6
.	.
.	.

B.

a	b
0	-3
1	-2
2	-1
3	0
.	.
.	.

C.

a	b
3	0
4	1
5	2
6	3
.	.
.	.

D.

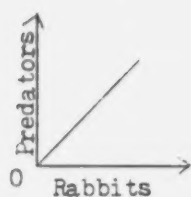
a	b
0	0
1	1
2	2
3	3
.	.
.	.

E.

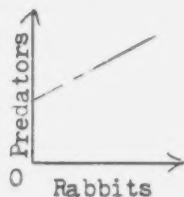
a	b
-2	0
-1	1
0	2
2	4
.	.
.	.

56. Which graph show a decrease in rabbits as predators increase?

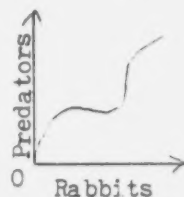
F.



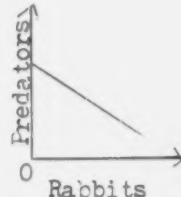
G.



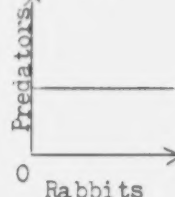
H.



J.



K.



Look at this data:

Year	Waste materials in (100 million tons)
1955	20
1960	26
1965	30
1970	39
1975	52
1980	65
1985	83

57. Which of these predictions is probably true?

- A. Waste material will be less in 1990
- B. Waste material will reach 200 units by 1990
- C. There is no trend shown by the data
- D. More waste material will be generated in the year 2000 than any data shown
- E. People are generating less waste material

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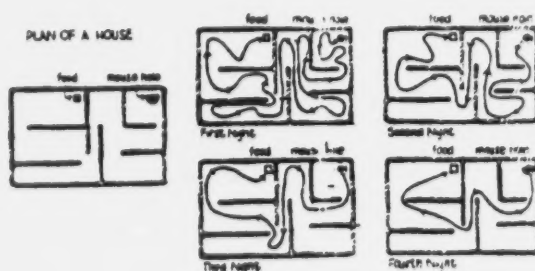
A survey was conducted 3 weeks before the election of a student body president. 150 students were asked who they preferred to vote for in the up-coming election. The summary of results are shown below.

Candidate	Number	% of total
Bill	27	18%
Carla	48	32%
Jim	42	28%
Juanita	33	22%
Totals	150	100%

58. Decide which statement is a fact.

- F. Carla will win the election .
- G. More people surveyed indicated that they will vote for Carla than for Bill.
- H. Bill will lose the election.
- J. Carla is smarter than Juanita.
- K. People liked girls better than boys.

Look at the pictures below that indicate the behavior of a hungry mouse.

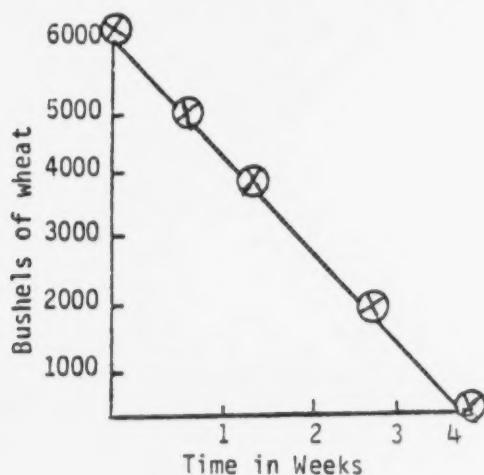


59. Which of these outcomes can you be sure of?

- A. The mouse was hungrier the fourth night.
- B. The mouse learned the shortest path from repeated trials.
- C. The mouse would follow the shortest path on a fifth trial.
- D. The mouse took the longest path on the first night.
- E. The mouse will teach her children the shortest path.

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Look at the line graph showing the use of stored grain fed to animals.



60. Which of the following is true?

- F. The grain consumed was the same for the 1st and 3rd weeks.
- G. Grain use decreased in week 3.
- H. The number of animals increased during the 3rd and 4th week.
- J. More grain was fed during the 3rd and 4th week
- K. The animals will not be hungry after 4 weeks of good food.

GO ON TO THE NEXT PAGE

61. A group of students conducted an experiment where they looked at onion skin under a microscope. The areas they saw that looked like rooms in a building are called _____ ?

- | | |
|-----------|------------|
| A. Tissue | D. Systems |
| B. Cells | E. Bodies |
| C. Organs | |

62. An organ is made up of similiar _____ ?

- | | |
|----------------|------------|
| F. Organs | J. Nucleus |
| G. Communities | K. Systems |
| H. Tissues | |

63. Several organs carrying out a specific life function make up _____ ?

- | | |
|----------------|-------------|
| A. a Colony | D. a System |
| B. a Community | E. Tissue |
| C. an Organ | |

64. Cells reproduce by _____ ?

- | | |
|--------------|-------------------|
| F. Diffusion | J. Secretion |
| G. Division | K. multiplication |
| H. Osmosis | |

65. Plants are like animals in all the following ways except?

- | | |
|--------------------|---------------------------------------|
| A. need for water | D. need for growth and development |
| B. need for energy | E. need for reproducing their species |
| C. need for food | |

66. Ann noticed that smaller animals came early in the day to drink from a jungle water hole. Later the larger predators came for water. Which of these things were probably true?

- F. The larger animals were polite to let the smaller animals drink first.
- G. The small animals came while the predators slept.
- H. The smaller animals were not afraid to come with larger animals present.
- J. The animals would not hurt each other.
- K. Animals observe a time each day when every animal can drink.

67. Of the comparisons shown which is the best way to distinguish plants from animals?

- A. movement
- B. color
- C. ability to reproduce
- D. ability to make their own food
- E. use of oxygen

68. Which of these statements is true?

- F. In a food web, there are more predators than consumers
- G. In a food web, the plant eaters are plants
- H. In a food web, the fewest organisms are predators
- J. In a food web, the producers are usually animals
- K. The fewest organisms in a food web are the consumers

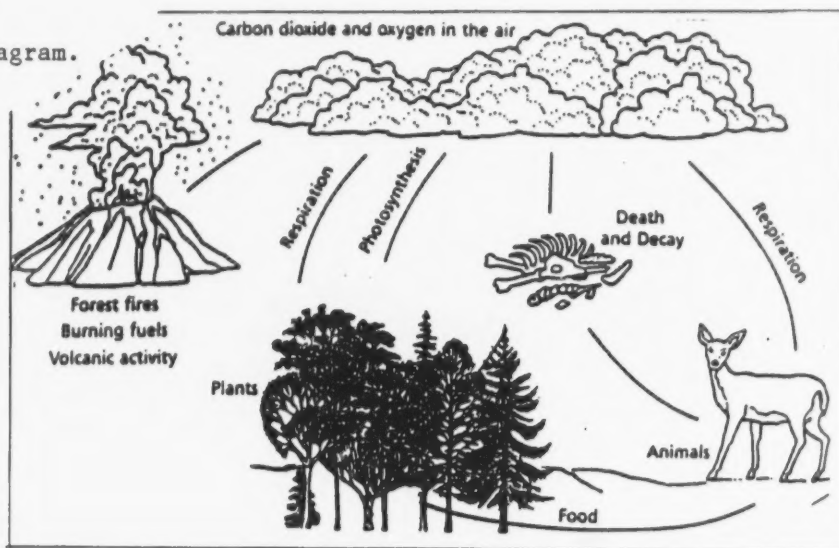
69. Which of these things is not recycled by living things over time?

- A. water
- B. nitrogen
- C. oxygen
- D. carbon dioxide
- E. energy

70. Which of these things is the source of nitrogen for plants?

- F. carbon dioxide
- G. water
- H. energy
- J. soil
- K. sun

71. Look at this diagram.



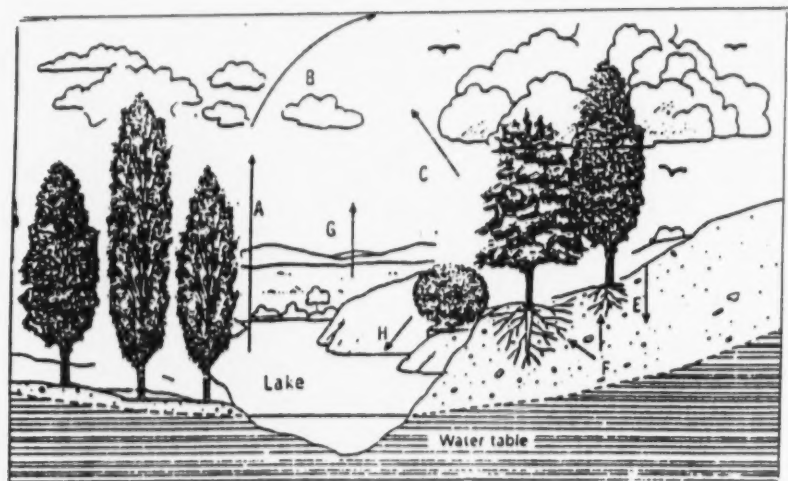
Which cycle is illustrated by the diagram?

- A. The nitrogen cycle
- B. The hydrogen cycle
- C. The water cycle
- D. The carbon dioxide cycle
- E. A life cycle

GO ON TO THE NEXT PAGE

72. The cycle shown by this diagram is?

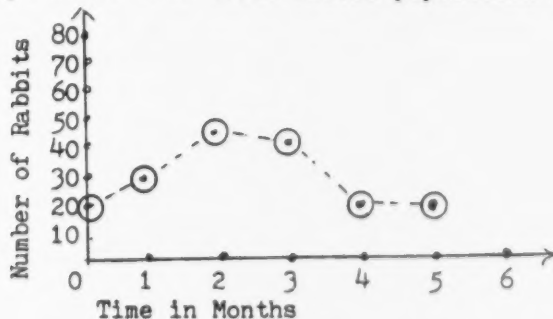
- F. water
- G. carbon dioxide
- H. nitrogen
- J. hydrogen
- K. life



73. Which of these cause our population to decrease?

- A. Increased water supply
- B. Disease increase
- C. Energy increase
- D. Mild temperature is obtained
- E. Increased food

74. The graph shows data about rabbit population in a certain area.



Which of the following must be true?

- F. The number of rabbits increased during the 1st and 2nd months.
- G. The food supply decreased during the 1st and 2nd months.
- H. Foxes discovered the rabbits after 2 months.
- J. The number of rabbits stay the same after 4 months.
- K. Disease caused some rabbits to die.

75. Which of these factors is not a population-control-factor?

- A. Disease
- B. Food supply
- C. energy supply
- D. Climate stability
- E. Water supply

76. A population of mice live in an area where grain is abundant. The population has been about the same for several years.

Which of these factors is probably true?

- F. There are no predators
- G. There has not been a serious drought
- H. There is no competition for the grain
- J. The mice live longer in this area
- K. The hawks do not eat the mice

Use this information for questions 77 and 78:

Several objects are sealed in a box. Students can hear objects roll, slide and tumble. One object is attracted by a magnet.

77. Which of these is a fair test to see if the round object is made of iron?

- A. Use a magnet to pull the object uphill inside the box and see if it rolls when the magnet is removed.
- B. Pick up the box using the magnet
- C. Weigh the box to show how heavy the iron makes it
- D. Shake all the objects to one end and use the magnet at the other end
- E. Lift the magnet away from the box until the object falls

78. What is the fair test to see if one object which slides is flat on both sides?

- F. Turn the box quickly to show both sides flat
- G. Use the magnet on top, then on the bottom
- H. Open the box to see the objects
- J. Build another box that weighs the same
- K. Spin the box until the object flips over

79. Fossils of sea animals are found in many places thousands of miles from the sea.

Which of these things does this show?

- A. They really aren't remains of sea animals.
- B. The area was once an ocean floor.
- C. The earth is becoming flat.
- D. The earth is becoming salty.
- E. Nature is full of surprises.

80. The water cycle tends to remain almost constant.

Which of these explanations is true?

- F. Most of our water is new.
- G. Precipitation is water that is used up.
- H. A geyser is evidence of water in the air.
- J. Water that most affects our weather is underground.
- K. The amount of water is conserved.

81. All of these are chemical changes except?

- A. Oxidation
- B. Melting
- C. Photosynthesis
- D. Burning
- E. Explosion

82. All of these are physical changes except?

- F. Solidification
- G. Gasification
- H. Condensation
- J. Oxidation
- K. Melting

83. Which of these is not a physical change?

- A. Solid to a gas
- B. Gas to a liquid
- C. Acid to a Base
- D. Liquid to a solid
- E. Solid to a liquid

84. Which of these is not a chemical change?

- F. Salt to a base
- G. Acid to a salt
- H. Water to a vapor
- J. Rusting
- K. Tarnishing

85. The body's waste-disposal system is?

- A. Circulatory
- B. Respiratory
- C. Nervous
- D. Excretory
- E. Reproductive

86. The body's food-use system is?

- F. Circulatory
- G. Digestive
- H. Nervous
- J. Excretory
- K. Respiratory

GO ON TO THE NEXT PAGE

87. The body's blood-use system is ?

A. Respiratory

D. Nervous

B. Digestive

E. Circulatory

C. Reproductive

88. The body's air use system is?

F. Circulatory

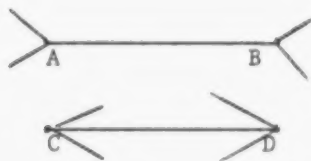
J. Reproductive

G. Respiratory

K. Excretory

H. Nervous

89. Look at the optical illusions shown below.



Hypotheses

a. Line 1 is longer than line 2.

b. Line 2 is longer than line 1.

c. Line 1 and line 2 have the same length

Which of these statements is a fair test of the hypotheses to see which is true?

A. Get the majority opinion of 20 people.

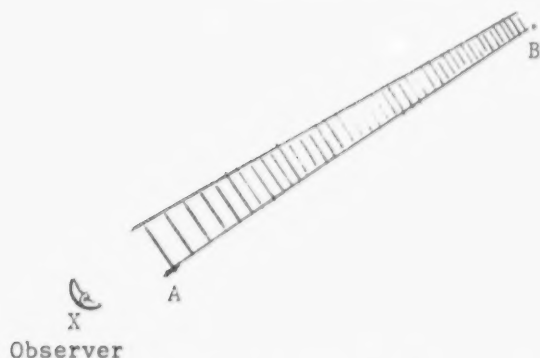
B. Get the majority opinion of 2000 people.

C. Measure line 1 and line 2 to see how the lengths compare.

D. Measure line 2 to show it is shorter.

E. Choose line 2 as the shorter line.

90. An observer looking down a railroad track saw what looked like the diagram shown. The following hypotheses were given.



Hypotheses

a. The tracks are more narrow as they go away from the observer.

b. The tracks are really the same width at points A and B.

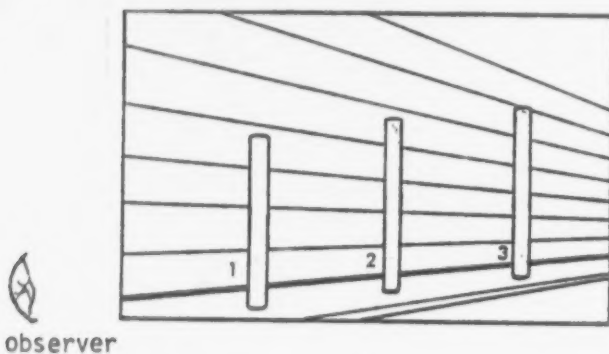
Question and choices for 90 on next page.

Problem 90 continued.

Which of these statements is a fair test of these hypotheses?

- F. Get a train to see if the tracks are too narrow at B.
- G. Take majority opinion of a 6th grade class.
- H. Measure width at both points and compare.
- J. Go to B and see if the tracks look narrow at A.
- K. Choose hypotheses A.

91. Look at the diagram shown below. Poles 2 and 3 are a distance behind pole 1 and you are observing from the left. How do the lengths of the poles compare?



Ed's class listed these hypotheses:

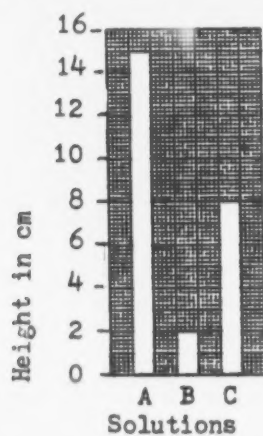
- 1. The poles are all the same length.
- 2. Pole 3 is longest.
- 3. Pole 2 is longer than pole 1.
- 4. Pole 2 is shorter than pole 3.
- 5. Pole 1 is shorter than poles 2 or 3.

Which of these statements is a fair test?

- A. A fair test for hypothesis #1 is to measure poles 2 and 3.
- D. A fair test for hypothesis 3 is to count how many horizontal lines there are to the top of the poles.
- C. A fair test is to take a picture to see if it matches the diagram.
- D. Go with the majority of opinion to determine heights.
- E. Observe from the top.

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92. The graph below shows how different solutions rise in celery stalks. Which explanation could not be true for this data?



- F. The solutions may be different concentrations of the same liquid.
G. The solution may be the same concentration of the same liquid at the same temperature.
H. Solution A seems to have the lowest density.
J. Solution B seems to have the highest density.
K. The solutions could be different liquids.

STOP.

APPENDIX D

CODING OF VOCATIONAL TASKS TO MATHEMATICS TOPICS BY AREA

The attached pages show individual coding of mathematical essential skills to vocational task descriptions. The codings intend to establish common ground where both mathematics teachers and vocational teachers are trying to develop and establish student mastery of these skills.

Suggested essential skills are at a minimal level. In some cases both areas go beyond these essential skills. For example, in metals the use of a Sine bar requires square root and trigonometry, electronics includes a lot of formulation, scientific notation and approximation.

The amount of diversity in course descriptions does exist in Colorado. The codings were established for what seemed to be the common elements and may not always include everything a particular course at a given school may include. Reference was made to national and state course descriptions. There is more agreement in the mathsarea of what a standard course of algebra might include. Each vocational teacher may want to add or delete certain topics to establish a local district coding.

The summary chart indicates a lot of the essential skills in mathematics are part of vocational courses. It is the purpose of the coding to allow some consideration for students on course requirement alternatives and to give vocational teachers models and examples to use in discussing this issue.

TOPIC CORRELATION - MATHEMATICS - VOCATIONAL EDUCATION

1. Drafting:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Basic Math Computation	Skills Computation
Reading Scales	Reading Scales
Bar and Line Graphs	Constructing Graphs
Geometric Constructions	Constructing Triangles, Ellipses and Polygons
Geometry Shapes	Single View Drawings

2. Electro-Mechanics:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Reading Meters and Dials	Reading and Using Meters
Networks (scaled diagrams)	Reading Schematics
Measurement	Measuring Wire Size and Lengths
Scientific Notation	Writing Large and Small Numbers
Manipulating Variables	Ohm's Law and Power Equations
Cost and Decimal Computations	Estimating Cost of Materials

3. Electronics:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Squares and Square Roots of Numbers	Skills Computation
Formulas and Variables	Ohm's Law and Electrical Power
Measuring Guages	Reading Meters
Formulas and Variables	Electrical Resistance, Capitanace Inductance and Series Resonance in Parallel and Series Circuits.

4. Food Service:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Measurement	Measuring Mass, Volume, Time and Temperature
Equivalent Fractions (ratios and proportions)	Adjusting Recipes & nutritional requirements
Whole number, fractional and decimal computations	Handling money, budgeting & cost, making change and paychecks
Fractions and Decimals to Percent	Percentage Computations

5. Auto Body:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Basic Skills Computation	Skills Computation
Area Measurement	Measuring for Welding and Repairs
Surface Area of Solids	Measuring for Repairs and Painting
Decimal and Money Computation	Estimating Parts and Labor

6. Health Occupations:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Measuring of Time and Temperature	- Taking temperature - Give bed bath - Give tub bath - Give an enema
Using Metric measure	- Taking blood pressure - Measuring intake and output - Administer medications and vaginal irrigation
Reading Scales for Whole Numbers Fractions and Decimals	- Taking Respiration Rates - Check Urine for Sugar
Ratio and Proportion	- Laboratory analysis of blood and urine - Taking blood pressure
Percentage	- Laboratory analysis of fluid levels
Analysis of Graphs and Charts	- EKG Testing and Analysis - Respiratory Testing - Following Therapy Guidelines

7. Industrial Arts:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Basic Mathematics Computation	Skills Computation
Descriptive Geometry	Mathematics Related to Drafting
Descriptive and Projective Geometry	Mathematics Related to Graphic
Formulas-Manipulating Variables	Mathematics Related to Electronics
Measurement and Decimal Computation	Mathematics Related to Construction
Area, Volume and Formulas	Mathematics Related to Power Transportation

8. Auto Mechanics:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Volume (Dry and Liquid Measure)	Performing Service Checks-Capacity (SE-01, 03, 04;AS-01, 02,39)
Measure of Length and Horse-Power	Service Checks (AS-04,AS-05, AS-08) and Capacity
Number Names and Denominate Numbers	Service Checks (AS-42, AS-52, AS-53 AA-21, AE-02, AE-23) Compression and Efficiency
Reading Scales	Service Checks with Dials, Controls and Speciality Measures (AS-44, AS-65, AS-37)

9. Metals:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Whole Numbers and Decimal Computations	Length, Area Volume Computations; Cost Estimates
Reading and Computing with Fractions	Reading Micrometer and Surface Area Measurements
Functions of the Right Triangle	Square Root Determination & Using Sine Bars
Measurement	Length, Area and Angles
Ratio and Proportion	Sine and Tangent Ratios
Formulas and Equations	Cutting Speed Determination & Cost Estimates
Rounding Numbers	Length and Areas to Fabricate Metal

10. Graphic Arts:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Descriptive Geometry	Single View Drawings
Scaling (Enlarge and Reduce)	Perspective Geometry
Scale Drawings	Pictorial Drawings (Orthographic and Oblique)
Spatial Relations	Printing and Engraving

11. Construction:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Basic Skills Computation with Whole Numbers and Decimals	- Measuring Day-to-Day - Finding Board Feet - Budgeting Materials
Measurement	- Length, Area and Volume Measure for Constructing Frames, Excavation and Foundations - Angle Measure for Rafters, Risers etc.....
Ratio and Proportion	- Weight to Strength Problems on Load-Bearing Structures - Vertical to Horizontal Distance Relations
Percentage	- Mixing Paint, Concrete, Adhesives and Cost Estimates
Interest	- Construction Loans and Cost Estimates
Rounding Numbers	- Accuracy in Measurement
Scale Drawings	- Using Blueprints

12. Commercial Art:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Basic Skills Computation with Whole Numbers and Decimals	- Finding Area of Figures - Determining Cost and Estimates
Scaling	- Enlarging and Reducing Drawings
Descriptive Geometry	- Constructing Triangles, Ellipses and polygons (cubes, spheres and conical objects)
Geometry Shapes	- Optical Illusions - Symmetry
Pictorial Drawings	- Perspective (Axonometric, perspective from 2 and 3 points and oblique drawings - orthographic projections

13. Agriculture:

MATHEMATICS CONTENT	VOCATIONAL TASK DESCRIPTION
Basic Skills Computation with Whole Numbers, Fractions and Decimals	- Day-to-Day Computation for Measures and Costs
Measurement	- Length, Area and Volume Measures
Percentage	- Mixtures of Fertilizers, Feeds Growth and soils
Interest	- Production Credit and Consumer Loans on Land and Machinery
Ratio and Proportion	- Feed to Weight gained, comparing Feeds, Breeds and Production Techniques - Comparing to other Ratios for market and production planning
Estimation and Prediction	- Crop Yields, Seeds needed efficiency measures, irrigation and amounts of chemicals to use

CODING OF VOCATIONAL TASKS TO
SCIENCE TOPICS BY AREA

The attached codings represent an effort to show Science content coded to individual vocational courses and indicates a summary of essential skills that science courses usually include. This inclusion at the application level is felt to be very significant in that students must represent a use of the science skill in their vocational area.

There is a great diversity in courses in vocational education in Colorado. The coding represents what is felt to be common or frequently included vocational task descriptions and may not fit well in a particular course at every school. Reference was made to other national and state descriptions¹ in addition to courses from local districts in Colorado². In spite of the diversity, There were for the most part general agreement of what constitutes a course in most of the vocational areas. Many teachers will find that they include some topics that may not be found in the coding.

Several of the vocational courses include science reference that goes beyond the suggested essential science skills. While the science topics are coded individually they are not always included in the summary sheet because they do go beyond the essential skills coverage and would code more directly to physics, biology or chemistry. The essential list of skills must be thought of as a minimal level of mastery.

-
1. The purpose is to establish a common ground of agreement, between vocational and academic science, of essential science skills so that some efficiency and joint efforts to lessen graduation requirements and course requirements can be made.
 2. Not all of the vocational courses are coded and there are multiple-year courses that are not included past the introductory year. With 13 of the courses included, perhaps a model is established so that another coding effort can be made to finish a comprehensive coding and summary.

1. Auto Mechanics:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Solutions and Mixtures	- Cooling Systems - Battery - Fuel Mixtures
Heat	- Brakes (friction) - Temperature Controls (Thermostat)
Electricity	- Terms for Voltage, Current and Resistance - Circuits - Power Sources, Fuses, Relays and Switches - AC and DC Currents - Testing for Currents and Voltage - Distributors and Components
Oxidation and Combustion	- Fuel and Combustion - Energy Transfer
Chemical Change	- Fuel to exhaust products

2. Drafting:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Mechanical Transfer	- Gears and Cams to Provide Power and Speed Advantage

3. Electronics:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Atomic Nature of Matter	- Identifies Nucleus, Proton Electron and Neutron
Electricity and Magnetism	- Attraction and Repulsion of Charged objects - Electromotive Force - Describes a battery or voltaic cell operation
Energy Formation	- Lists six sources of Electricity - Power - Transformers and Rectifiers
Electric Circuits	- Diagnoses Circuits - Identifies AC & DC Current - Series and Parallel Circuits
Formulas and Variables	- Voltage/Current/Resistance $E = IR$ (Ohm's Law)
Inductance	- Measures Effects with AC and DC Circuits
Capacitance	- Identifies the Principals of Capacitance

4. Metals:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Heat Energy	- Heat Transfer and Heat Distortion - Metal Expansion and Contraction - Fusion of Metals - Heat Treating Principles
Electricity (Energy)	- Arc Wealding - Soldering - Electrical Circuits - Electrodes and Ground Leads - Welding Transformers

5. Industrial Arts:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Solutions and Mixtures	- Solvents - Plastics, Cement and Paint Mixtures
Heat (Energy)	- Cooling Systems - Welding, Soldering and Mixing Ingredients - Friction and Lubrication
Electricity	- Batteries - Terms for Basic Electricity and Magnetism - Circuits, Fuses and Insulators - Electrical Codes - Electrical Instruments
Simple Machines	- Cams, Gears and Differentials - Transmission of Power & Speed
Oxidation and Combustion	- Fuel Sustems

6. ELECTROMECHANICS:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Atomic Nature of Matter	- Identifies Nucleus, Proton, Electron and Neutron.
Electricity and Magnetism	- Attraction and repulsion of charged objects - Electromotive Force - Describe a battery or voltaic cell - Operation of Conductors, resistors and diodes
Energy Formation	- Lists any sources of electricity - Power control - Transformers and rectifiers
Electric Circuits	- Diagrams circuits, installs breakers - Identifies AC and DC current - Series and parallel circuits
Formulas and Variables	- Voltage/Current/Resistance relations $E = IR$ (Ohm's Law)
Inductance	- Measures effects with AC and DC circuits - Installs electrical devices
Capacitance	- Identifies the principles of capacitance - Installs electrical devices
Metal Expansion & Contraction	- Describes operation of a thermostat

7. HEALTH OCCUPATIONS:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Solutions and Mixtures	- Prepares irrigation solutions - Saline & Glucose Solutions - % Glucose in blood - % sugar in urine
Volume and Pressure	- Blood pressure - Count respiratory rate - Input-output ratios - Measures pulse rates - Measures temperature and blood pressure
Density and Specific Gravity	- Performs tests on body fluids - Laboratory analysis
Acids and Bases	- Measures Ph of fluids - Laboratory analysis
Elements and Compounds	- Using Oxygen with patients
Humidity	- Maintaining control of environment for patients - Humidity/aerosol therapy - Infection control

(HEALTH OCCUPATIONS Cont. on next page)

(HEALTH OCCUPATIONS CONTINUED)

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Respiration	- Measurement - Controlled Environment - Medical gas therapy
Life Functions	- Measuring temperature, pressure, respiration, etc...

8. FOOD SERVICES:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Elements Compounds and Mixtures	Food Groups: - Sugar, Starch and other carbohydrates - Proteins - Fats
Chemical and Physical Change	- Yeast Production - Temperature changes (cooking & Freezing) - Volume changes
Chemical Identification	- Preservatives - Contamination - Disease prevention & sanitation
Plants & Animals	- Algae, yeast, pests and contamination by organisms

9. CONSTRUCTION:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Simple Machines	- Using handtools - Moving heavy objects up-and-down
Heat	- Insulation - Control and Measure
Electricity	- Installing grounds, outlets, meters switches and cables - Wiring circuits - Installing electrical controls, alarms and intercommunication devises
Solutions and Mixtures	- Mixing mortar, cement, texturing mixture and paint
Metal Expansion and Contraction	- Instal expansion joints - Install thermostats - Thaw frozen pipes

10. AUTO BODY:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Electricity	- Electrical welding
Elements & Compounds	- Gas welding (acetylene) - Sealers

11. GRAPHIC ARTS:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Solutions & Mixtures	- Preparing photographic solutions & rinses - Use and preparation of dark room chemicals - Printers ink
Proportional Scaling	- Enlargements and Reductions

12. COMMERCIAL ART:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Solutions & Mixtures	- Identifying and applying transparent watercolors - Inking equipment - Using transfer shields - Silk screening
Proportional Scaling	- Enlargements and Reductions
Chemistry	- Identifying chemicals - preparing mediums

13. AGRICULTURE:

SCIENCE CONTENT	VOCATIONAL TASK DESCRIPTION
Solutions & Mixtures	- Preparing herbicides, pesticides and fertilizers - Ph control for soil and water
Plants and Animals	- Growth and Developments - Pest control - Production
Energy	- Heat and electricity fundamentals and controls - Soil temperatures - Electrical devises; batterys, fences,etc
Chemical & Physical Change	- Lifecycles and ecosystems
Conservation of Substance	- Soil conservation
Life Functions	- Environmental controls
Simple Machines	- Farm shop tasks
Hydralics & Fluid Dynamics	- Using equipment; pumps, loaders, backhoe etc....
Genetics	- Hybrid plants and animals - Improving production and yeilds